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Memorandum

To: Norman W. Bernstein
Peter M. Racher
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Date: July 30, 2019

From: McMillan-McGee Corporation

Re: Third Site Remediation Completion

This memorandum is to explain completion of remediation at The Third Site in Zionsville, Indiana. Remediation has been completed based on the sum of concentration of volatile contaminants collected from monitoring wells P-1, P-2, P3, MW-27R, and the Sump. The compound 1,2-dichlorobenzene (1,2-DCB) has been excluded from this calculation due to this contaminant not being a contaminant of concern (COC). This conclusion is based on the considerations outlined below.

Contaminant Boiling Points

The suitability of a contaminant for ISTR depends on the ability to volatilize that contaminant, so that it is mobilized to an extraction point. The vapor pressure of the contaminant at operating temperatures (~100 °C) governs how easily it may be mobilized and remediated; since these data are often not readily available, the boiling point of the contaminant is typically used as a convenient proxy to determine whether a contaminant is suitable for ISTR. This is reflected in a number of guidance manuals for various ISTR technologies. The Indiana Department of Environmental Management's *Technical Guidance Document, In-Situ Thermal Remediation* states that:

“Liquid phase compounds with boiling points less than that of water are nearly completely removed while the process is considered effective for liquid hydrocarbons with boiling points up to 175 °C.”¹

United States Environmental Protection Agency (USEPA) document *Ground Water Issue, Steam Injection for Soil and Aquifer Remediation* has very similar language:

¹ Available at https://www.in.gov/idem/cleanups/files/remediation_tech_guidance_in-situ_thermal.pdf, retrieved on July 24, 2019.

“...liquid hydrocarbons having boiling points up to 175°C may also be completely removed directly behind the steam condensation front.”

Similarly, the US Army Corp of Engineers’ *Engineer Manual Design: In Situ Thermal Remediation* defines high boiling point compounds for electrical resistance heating as “>100 and <150°C”.² Note that the boiling point of 1,2-DCB is 180 °C, and thus this compound is outside of the range of compounds considered suitable for boiling water-temperature ISTR, as it is not sufficiently volatile to be remediated at boiling water temperatures.³

It is important to understand that high boiling point and corresponding low volatility of 1,2-DCB sets a hard limit on the treatability of that compound using boiling-water temperature ISTR. While some monitoring points at the site have shown significant concentration decreases, the mechanism of these decreases may be due to physical groundwater extraction (‘pump and treat’) as opposed to volatilization. Comparing to the site COC trichloroethene (TCE), the vapor pressure of 1,2-DCB at 100 °C is 0.084 atmospheres, while that of TCE is 1.43 atmospheres. This difference in volatility exemplified by the vapor pressure allows TCE to be readily remediated at 100 °C, while 1,2-DCB remains recalcitrant. Continuing thermal operations in the hopes of remediating 1,2-DCB is a pointless endeavor that could continue for the foreseeable future without results.

The choice of boiling-water temperature ISTR as the remediation technology for the site indicates acceptance of the limitations of the technology. Mc² encourages the Trust to review the scientific literature regarding this subject, as we believe this fully substantiates our position. This is further borne out by the definition of volatile organic compounds (VOCs) in documents from the USEPA, the Trust, and Mc², as described below.

Volatile Organic Compounds Definition

It has been noted in verbal communication by the Trust’s consultant that 1,2-DCB appears on the United States Environmental Protection Agency (USEPA) Method 8260, *Volatile Organic Compounds by Gas Chromatography/Mass Spectrometry* analyte list, and asserted that this indicates that 1,2-DCB is considered a VOC; however, note that 1,2-DCB also appears on the analyte list of USEPA Method 8270, *Semivolatile Organic Compounds by Gas Chromatography/Mass Spectrometry*; by the same logic, 1,2-DCB is a semi-volatile organic compound (SVOC).

² Available at <https://clu-in.org/download/techfocus/thermal/Thermal-In-Situ-EM-200-1-21-1.pdf>, retrieved on July 24, 2019.

³ U.S. National Library of Medicine, PubChem database, *Compound Summary*, 1,2-Dichlorobenzene, retrieved from https://pubchem.ncbi.nlm.nih.gov/compound/1_2-dichlorobenzene on July 24, 2019.

The Contract between the Trust and McMillan-McGee Corporation (Mc²) does not include any definition of volatile organic compounds or VOCs in Article 18, Definitions, or in any other portion of the Contract. The contract incorporates the following relevant technical documents:

- The Consent Order dated November 21, 2002, including the Enforcement Action Memorandum (“EAM”) dated May 11, 2001;
- The Environ 2004 Design; and,
- The accepted Mc² design document.

The Consent Order states:

“Six VOCs were identified as the contaminants of concern based on historic and recent sampling at the site. The following compounds were found in site soil and groundwater: tetrachloroethene (PCE), trichloroethene (TCE), cis-1,2 dichloroethene (cis-1,2 DCE), vinyl chloride, Trans-1,2 dichloroethene (Trans-1,2 DCE), and 1,1-Dichloroethene.”

Note that 1,2-DCB does not appear in this list of contaminants of concern. The Consent Order does mention 1,2-dichlorobenzene, but in the context of VOCs and SVOCs:

“Soil sample results showed elevated levels of VOCs **and SVOCs** [emphasis added] such as tetrachloroethene (548,000 ppb), 1,1,1-trichloroethane (913,000 ppb), trichloroethene (3,310,000 ppb), xylene (1,020,000 ppb) and 1,2-dichlorobenzene (1,280,000 ppb).”

The EAM states:

“VOCs identified as the contaminants of concern based on their occurrence in soil (measured in ug/kg) and/or groundwater (measured in ug/l), and their maximum concentrations are as follows: tetrachloroethene (330,000 ug/kg, 36 ugh); trichloroethene (350,000 ug/kg, 870 ug/l); cis-1,2-dichloroethene (130,000 ug/kg, 29,000 ug/l); vinyl chloride (4,800 ug/kg, 860 ug/l); trans-1,2-dichloroethene (930 ug/kg, 100 ug/l); 1,1,1-trichloroethane (49,000 ug/kg, 5,800 ug/l); 1,1,2-trichloroethane (ND, 12 ug/l); 1,1-dichloroethane (23,000 ug/kg, 780 ug/l); and 1,1-dichloroethene (100 ug/kg, 160 ug/l).”

Note that 1,2-DCB does not appear in this list.

The 2004 Environ Design includes the same nine contaminants of concern identified in the EAM. Nowhere in the text of the 2004 Environ Design does 1,2-DCB appear.

Finally, *Remedial Design Report, Third Site ERH, Zionsville, Indiana* prepared by Mc² and approved by the USEPA and the Trust, lists the same nine contaminants of concern (tetrachloroethene, trichloroethene, cis-1,2-dichloroethene, vinyl chloride, trans-1,2-dichloroethene, 1,1,1-trichloroethane, 1,1,2-trichloroethane, 1,1-dichloroethane, and 1,1-dichloroethene) in Table 4, and excludes 1,2-DCB.

Based on this review of the documents specifically included in Mc²'s contract with the Trust, it is our conclusion that adding 1,2-DCB to the list of VOCs to be remediated is not only technically inaccurate, but represents an unfounded addition to Mc²'s scope. The list of contaminants of concern (COCs) that Mc² bid to remediate, that was presented in the contract documents, and that were listed in Mc²'s approved design did not include 1,2-DCB.

Sampling Results

Recent sampling results are shown on Chart 1 and Chart 2, attached. The figures show total detected VOCs, excluding 1,2-dichlorobenzene in accordance with the above conclusion. As is evident from the charts, groundwater samples from all sample wells have met the performance criteria for at least two consecutive sample events.

Summary

The substance 1,2-DCB is not a volatile organic compound suitable to being remediated by boiling-water temperature ISTR; nor is it a site COC per the contract documents. Continued thermal operations in the hopes of remediating 1,2-DCB could continue indefinitely without fruitful results.

ERH remediation at the Third Site has successfully remediated site Total VOCs to the specified performance standards. Mc² requests that the Trust proceed with confirmatory groundwater sampling at the DNAPL Containment Area and ATT Area monitoring wells.

Chart 1: DNAPL Containment Area Total VOCs

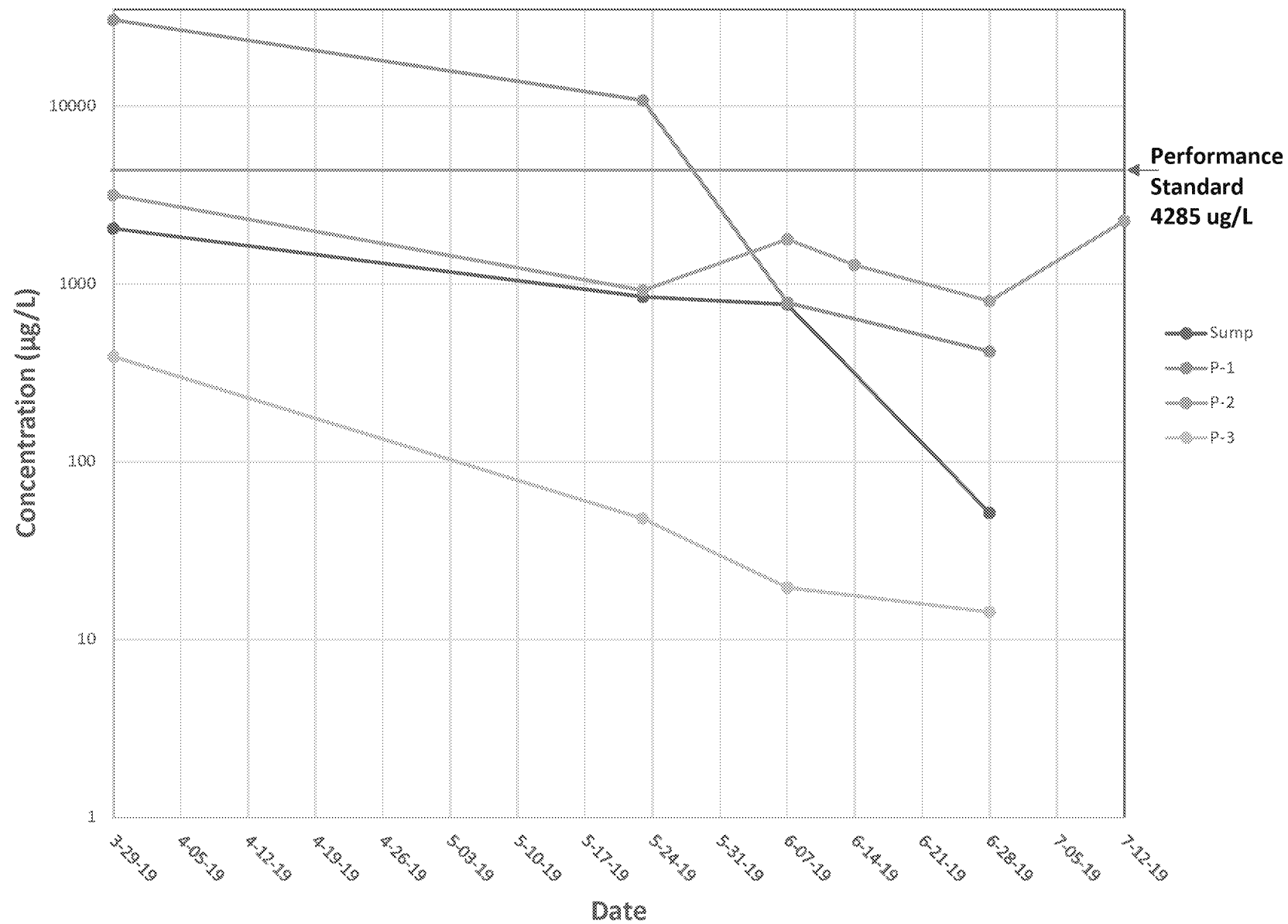


Chart 2: ATT Area Total VOCs

